Rediscovery of Ooline, *Cadellia pentastylis*, near Gunnedah: notes on the habitat and ecology of this dry rainforest tree

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**Abstract:** *Cadellia pentastylis* F.Muell., (family Surianaceae), a dry rainforest tree with a conservation listing of Vulnerable at state and national levels, was first collected from the Gunnedah area by the botanical collector J.L. Boorman in 1907. We report the first record of *Cadellia pentastylis* from the Gunnedah area (30°58'49''S, 150°15'15''E) since 1907, and provide details of the community and habitat where it occurs, on the lower slopes of Black Jack Mountain. Although this population is one of the smallest in New South Wales, it is significant as it is at its southern distributional limit, and is found adjacent to semi-evergreen vine thicket, another type of dry rainforest, on the same hillslope. We list the New South Wales occurrences of this species and discuss aspects of its flowering phenology.


**Introduction**

Botanical exploration is replete with tales of rediscovery of species or populations thought to be lost from an area; e.g. the rediscovery of the cool-temperate rainforest species *Nothofagus moorei* on the Comboyne Plateau (Bale & Williams 1994) or the suspected demise and subsequent rediscovery of *Hakea pulvinifera*, an extremely rare species known only from a single hillside near Lake Keepit east of Gunnedah (Leigh et al. 1984; Barker & Morrison 1989). In 1994, Bob Howarth of Gunnedah brought samples of a ‘red-flowered’ tree collected on Black Jack Mountain, south-west of Gunnedah to one of us (SRC). At the time, the samples could not be identified, but several years later SRC recognized the line drawing on the cover of Benson’s (1993) Ooline Species Management Plan as resembling Howarth’s specimen. No reference could be found to *Cadellia pentastylis* F.Muell. having red petals or sepals (Beadle 1984 cited in Benson 1993; Harden 2002) and the matter was taken no further.

In November 2004, *Cadellia pentastylis* flowered extensively in the Narrabri district (James Faris & Geoff Robertson, pers. comm.). Specimens and photographs of the early stages of fruit development showed that the petals had fallen with the light brown to red coloured sepals persisting. When shown specimens in fruit, Bob Howarth confirmed that they were similar to those that he had seen in 1994, and showed TJC the locality of the plants now confirmed as *Cadellia pentastylis*.

This was not the first record of *Cadellia pentastylis* from the Gunnedah area. In 1907, the botanical collector John Lucas Boorman lodged a sterile specimen at the National Herbarium of NSW (NSW 362008) but there are few details to accompany this specimen and the locality referred simply to “Gunnedah” (Peter Hind pers. comm. 2005). The species has not been recorded in the locality since but given the scant location details provided by Boorman, it is not possible to determine if the population he collected from is the same one reported here.

*Cadellia pentastylis* is a medium to large tree, known colloquially as ‘Ooline’ or ‘Scrub Myrtle’ (Benson 1993). It is the only member of its genus (Harden 2002) and is placed in a family, Surianaceae, which has only four genera (of which three are monotypic) and five species (Ian Telford pers. comm.). *Cadellia pentastylis* is of rainforest origin (Benson 1993) and its putative closest living relative, *Guilfoylia monostylis*, is a shrub or small tree found in several rainforest types on the east coast of Australia.

*Cadellia pentastylis* is endemic to the North Western Slopes of NSW and southern and central Queensland south from near Emerald (Gwen Harden pers. comm.). Since European settlement, much of the natural habitat of *Cadellia pentastylis* has been cleared for cropping or grazing (Benson 1993). It is now listed as a Vulnerable species under the NSW Threatened Species Conservation (TSC) Act 1995 and under the Commonwealth Environment Protection and Biodiversity Act 1999. Furthermore, the *Cadellia pentastylis* community is listed as an Endangered Ecological Community in NSW under the TSC Act.

In this paper we describe the vegetation and habitat of the *Cadellia pentastylis* population on Black Jack Mountain, and relate the timing of flowering to rainfall records from Gunnedah.
Methods

Survey work on Black Jack Mountain was conducted in December 2004 and January 2005 to describe the environment and vegetation associated with Cadellia pentastylis. The boundaries of the Cadellia pentastylis population were recorded with a global positioning system. A species list was compiled from foot traverses through the two stands and from data collected for a 20 m x 20 m floristic plot undertaken as part of a larger survey of dry rainforest. The density of Cadellia pentastylis was estimated by recording the number of individuals from three different size classes (large tree — diameter at breast height (DBH) > 10 cm; small tree — DBH < 10 cm; seedling < 50 cm height) in each of four 20 m x 20 m plots in the eastern stand which were located to sample the range of densities. Benson (1993) noted the ability of Cadellia pentastylis to coppice, and this presents problems in estimating the number of individuals. For our density counts we recorded any separate stem that was not obviously attached to another stem as a separate individual. Specimens of Cadellia pentastylis were collected (TJ Curran 201) and have been lodged in the NCW Beadle Herbarium (NE), the Australian National Herbarium (CANB), the National Herbarium of NSW (NSW) and the Queensland Herbarium (BRI).

To look for any additional stands of Cadellia pentastylis on nearby hills to the north and south of the Black Jack Mountain population we used binoculars to survey from public roads. Monthly rainfall records for the Gunnedah area for 2004 (Namoi Valley Independent 2005) were compared with long term means from the Bureau of Meteorology (2005) to examine rainfall patterns in the months preceding the flowering and fruiting of Cadellia pentastylis.

Results and discussion

Habitat, ecology and statewide distribution

The Black Jack Mountain population of Cadellia pentastylis is on the upper slopes of a low hill (31°0’36”S, 150°11’21”E) approximately 7.5 km WSW of Gunnedah, upslope from the former coal washery at Black Jack Colliery, to the north of Black Jack Mountain. There were two separate stands approximately 100 m apart: one on a north-west facing slope; the other on a north and north-east facing slope. The stands typically occur on skeletal sandy loam soils, on generally steep slopes (18–30°) at altitudes of 430–480 m.

The geology of the hillslope is complex, being a mix of igneous rocks, sediments and metamorphosed sediments. The habitat occupied by Cadellia pentastylis is predominantly conglomerate, either of the Black Jack Formation of Upper Permian age or Digby Conglomerate of Triassic age (NSW Dept. of Mines 1971a; Dept. of Mineral Resources 1996). Black Jack Mountain, upslope to the south, is capped by igneous rocks interpreted as Tertiary basalt (NSW Dept. of Mines 1971a) or as Glenrowan Intrusives (Late Jurassic sills and dykes) (NSW Dept. of Mineral Resources 1996). Known as the Black Jack Sill, this volcanic cap is listed on the Register of the National Estate as a geological reference site for igneous intrusions (Australian Heritage Commission 1993).

In both stands Cadellia pentastylis is the dominant species, with occasional Geijera parviflora or Callitris glaucophylla, or on the western edge of the western stand, Eucalyptus albens, in the canopy. Other small tree species associated with the two Cadellia pentastylis stands included Ehretia membranifolia, Notelaea microcarpa var. microcarpa, Alphitonia excelsa, Eremophila michellii, Capparis michellii and Alectryon oleifolius subsp. elongatus. Shrubs present included Croton phebaliioides, Rhagodia parabolica, Beyeria viscosa, Acacia decora, Maytenus cunninghamii, Canthium odoratum, Solanum parviflora, Abutilon tubulosum, Abutilon oxyccarpum and Olearia sp. aff. elliptica. Vines such as Parsonia lanceolata, Pandorea pandorana and Marsdenia viridiflora were abundant in places and Parsonia eucalyptophylla was also present. The ground cover, which was sparse in places where there was a dense canopy of Cadellia pentastylis and other species, comprised grasses such as Aristida gracilipes, Digitaria brownii and Cymbopogon refractus, herbs such as Malvastrum americanum, Einadia nutans subsp. linifolia, and Einadia hastata, and the fern Cheilanthes distans. Of particular interest was the abundance of the epiphytic orchid, Cymbidium canaliculatum, which occurred in high densities on Cadellia pentastylis.
The vegetation upslope and to the west of the *Cadellia pentastylis* community was *Eucalyptus albens* shrubby woodland; downslope and to the south of the *Cadellia pentastylis* was semi-evergreen vine thicket (SEVT) dominated by *Ehretia membranifolia*, *Geijera parviflora* and *Notelaea microcarpa* var. *microcarpa*. Many species common to both the SEVT and *Eucalyptus albens* woodlands were found in the *Cadellia pentastylis* community.

It is likely that there are more stands of *Cadellia pentastylis* on north-east facing slopes on a low ridge to the north of Black Jack Mountain. This ridge has similar geology to the low ridge we sampled and though we did not visit this area on foot, inspection with binoculars from Black Jack Road showed trees of the same colour and texture as *Cadellia pentastylis*. If this ridge does support *Cadellia pentastylis* it is likely that these stands are considerably larger than the ones reported in this paper. It is also possible that there are smaller stands on the eastern slopes of Black Jack Mountain further south.

While *Cadellia pentastylis* has an extensive, though threatened, distribution in southern Queensland, it is known from only a few locations in NSW (Benson 1993; Geoff Robertson pers. comm.; Table 1; Fig. 1). The population at Black Jack Mountain, Gunnedah is the southern-most known population. To the north the nearest known population is at Turkey Ridge, near Maules Creek approximately 60 km away (Benson 1993). Though the Black Jack Mountain population appears to be one of the smallest in NSW, it is of high conservation significance as it is at the southern distributional limit of the species.

### Table 1. Location, spatial extent, estimated size and geology of *Cadellia pentastylis* populations in NSW. Sources: 1 Benson (1993); 2 DEC (unpubl.); 3 Lachlan Copeland pers. comm.; 4 Hunter (2002); 5 Julian Wall pers. comm.; 6 Forestry Commission of NSW (1989); 7 NSW Dept. of Mines (1971b); 8 this paper. Where all information for a population is from the one source, that source is given with the location, otherwise the source is given for each datum. Populations are arranged in north to south order.

<table>
<thead>
<tr>
<th>Location</th>
<th>Estimated area (ha)</th>
<th>Estimated population size</th>
<th>Geology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenterfield Creek Gorge, W of Tenterfield</td>
<td>100–200+1</td>
<td>35 000+1</td>
<td>Claystone1</td>
</tr>
<tr>
<td>“Taronga”, Mole River</td>
<td>8–10</td>
<td>3900+1</td>
<td>Claystone1</td>
</tr>
<tr>
<td>Rock of Gibraltar, W of Tenterfield</td>
<td>21+2</td>
<td>1000+3</td>
<td>Acid volcanics5, likely Gibraltar Ignimbrite–ignimbrite rhyolite6</td>
</tr>
<tr>
<td>Gibraltar Nature Reserve, W of Tenterfield</td>
<td>&lt; 1+5</td>
<td>&lt; 100+4</td>
<td>Sediments5, likely Bodonga Beds–Early Permian conglomerate, sandstone or minor siltstone4</td>
</tr>
<tr>
<td>Bunal Flora Reserve, Bunal State Forest, NW of Ashford6</td>
<td>Unavailable</td>
<td>Unavailable</td>
<td>Jurassic Warialda Sandstones</td>
</tr>
<tr>
<td>Crooble</td>
<td>Unavailable – remnant trees2</td>
<td>30+2</td>
<td>Unavailable, possibly Tertiary gravels, sands or clays7</td>
</tr>
<tr>
<td>Gravesend</td>
<td>75–100+2</td>
<td>21 000+1</td>
<td>Sandstone–Claystone1</td>
</tr>
<tr>
<td>Biniguy</td>
<td>Unavailable+2</td>
<td>Unavailable+2</td>
<td>Unavailable, possibly Tertiary gravels, sands or clays7</td>
</tr>
<tr>
<td>“Tara”, Warialda</td>
<td>10–12+1</td>
<td>2700+1</td>
<td>Quartz Sandstone1</td>
</tr>
<tr>
<td>Gamilaraay Nature Reserve and surrounds, Terry Hie Hie7</td>
<td>113 (in reserve) + 262 (private land)</td>
<td>122 000</td>
<td>Recrystalised Quartzite - Sandstone</td>
</tr>
<tr>
<td>Mehil Flora Reserve, Mehil State Forest, E of Bingara6</td>
<td>Unavailable</td>
<td>Unavailable</td>
<td>Ordovician sediments</td>
</tr>
<tr>
<td>Campbell State Forest, Terry Hie Hie</td>
<td>Few plants+2</td>
<td>Few plants+2</td>
<td>Unavailable, possibly Jurassic Warialda Sandstone or Rocky Creek Conglomerate7</td>
</tr>
<tr>
<td>Deriah State Forest and nearby areas (e.g. Eulah Creek), Narrabri</td>
<td>186+1–240+2</td>
<td>54 000+1</td>
<td>Alluvium / Lithic Sandstone / Claystone4</td>
</tr>
<tr>
<td>Turkey Ridge, Maules Creek</td>
<td>350–400+1</td>
<td>74 000+1</td>
<td>Wean Formation Conglomerate+1</td>
</tr>
<tr>
<td>Black Jack Mt, Gunnedah8</td>
<td>2</td>
<td>1000</td>
<td>Conglomerate (Digby or Black Jack Formation)</td>
</tr>
</tbody>
</table>
Benson et al. (1996) observed that in NSW SEVT and Cadellia pentastylis communities do not mix. In recent extensive sampling of dry rainforest vegetation (including SEVT and Cadellia pentastylis communities) on the western slopes of NSW (Curran in prep.), Cadellia pentastylis was not encountered growing with SEVT, though some stands, e.g. parts of the Deriah State Forest and Warialda populations, are very similar to SEVT in species composition. On Black Jack Mountain, there were extensive stands of SEVT, including patches immediately downslope and across-slope (to the south) from the Cadellia pentastylis. The igneous (basalt or dolerite) influence on parts of the hill, coupled with the likely deeper soils further downslope, could explain the presence of SEVT in such close proximity to Cadellia pentastylis. Benson (1993) noted a strong correlation between Cadellia pentastylis and either lithic sandstone or conglomerate substrates (see Table 1), and observed that southern stands tend to have northerly aspects. These patterns are consistent with the Black Jack Mountain population, which occurs on northerly aspects on conglomerate. This represents a likely stressful habitat, being both low in nutrients and low in moisture availability (likely on sandy loam or sandy clay and often skeletal soils with northerly aspect exposed to desiccating winds). In contrast, SEVT is mostly associated with higher nutrient, basalt-derived soils (Benson et al. 1996), though it does occur on conglomerates of the Black Jack Formation south of Curlewis (Curran in prep.). The vegetation of Black Jack Mountain may provide a natural laboratory to further explore the causal factors underpinning the distinction between SEVT and Cadellia pentastylis communities.

The Black Jack Mountain population of Cadellia pentastylis is largely unaffected by two of the major threats to the species - land-clearing and livestock over-grazing (Benson 1993). Though located on private land near a former coal mine, there is no immediate threat of land-clearing as the mine has closed down and the mine site is being restored. This presents an opportunity to plant additional Cadellia pentastylis nearby, though there is no evidence to suggest that the population has been reduced in extent by past clearing. However, there are some stumps of unidentified trees downslope of the population. The area is not currently grazed by livestock. A potential threat to the population is the lack of recruitment; further research is needed to assess the implications of this. While Cadellia pentastylis may be vulnerable to fire (Benson 1993), there is nothing to suggest there is a high fire threat at Black Jack Mountain, and the limited access to the site (via private road) helps prevent arson.

### Population size

The two stands of Cadellia pentastylis occupy approximately 2 ha — western stand 0.9 ha, eastern stand 1.0 ha. Sampling in the eastern stand showed a range of densities (Table 2); from 175 plants per ha in the sparsely populated Plot 3, to 1125 per ha in a plot with particularly dense Cadellia pentastylis (Plot 4; Fig. 2). The average density was 531 ±206 per hectare, giving a total estimate of 1009 ±392 plants for the two stands on Black Jack Mountain.

### Flowering and fruiting and timing in relation to rainfall

Bob Howarth collected the flowering specimen of Cadellia pentastylis in 1994 in the middle of a severe drought in the Gunnedah area. Drawing on anecdotal information from landholders near other Cadellia pentastylis stands in NSW, Benson (1993) suggested that the species appeared to flower sporadically, with the last (i.e. pre 1988) previous profuse flowering reported from October 1986, which was

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**Table 2. Number of individuals of Cadellia pentastylis of different size classes in each of four 20 m x 20 m plots and mean stems per ha in the eastern stand on Black Jack Mountain, Gunnedah**

<table>
<thead>
<tr>
<th>Size class</th>
<th>Plot 1</th>
<th>Plot 2</th>
<th>Plot 3</th>
<th>Plot 4</th>
<th>Mean stems /ha (± s.e.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large tree (&gt; 10 cm DBH)</td>
<td>14</td>
<td>9</td>
<td>7</td>
<td>15</td>
<td>281 (± 48)</td>
</tr>
<tr>
<td>Small tree (&lt; 10 cm DBH)</td>
<td>4</td>
<td>6</td>
<td>0</td>
<td>30</td>
<td>250 (± 169)</td>
</tr>
<tr>
<td>Seedling (&lt; 50 cm height)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total plants</td>
<td>18</td>
<td>15</td>
<td>7</td>
<td>45</td>
<td>531 (± 206)</td>
</tr>
</tbody>
</table>

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Fig. 2. Dense stand of Cadellia pentastylis at Black Jack Mountain, Gunnedah showing thick leaf litter and sparse ground cover. Plot 4 was located in this stand.
a dry year on the North Western Slopes. More recently, the species was noted fruiting extensively in December 2002 at Rock of Gibraltar, west of Tenterfield (Lachlan Copeland, pers. comm.), at the height of a very severe drought in NSW (Bureau of Meteorology 2003).

In 2004 Gunnedah recorded above average rainfall of 795 mm (Namoi Valley Independent 2005) against a long term average of 636 mm (Bureau of Meteorology 2005). This was mainly due to large falls in January (175 mm), February (106 mm) and December (186 mm) (Fig. 3a). In the Narrabri and Gunnedah areas the most recent extensive flowering of Cadellia pentastylis was in November 2004. Despite the above average rainfall at Gunnedah in 2004, the months preceding the likely onset of flowering were characterized by drier conditions - rainfall was below average for the three, six and eight month periods to 31st October 2004 (Fig. 3b). This suggests that this recent flowering of Cadellia pentastylis might also have been triggered by dry conditions.

There was prolific fruiting in the Cadellia pentastylis population prior to and during sampling; and large amounts of seed were lying on the ground. Some was collected for germination trials.

No seedlings were recorded in any of the plots, though there were four probable seedlings on the south-eastern edge of the population. However, because these were close to an adult stem (i.e. within 5 m) it is possible that they were simply young coppicing stems from the adult plant. Benson (1993) noted that seedlings were rarely observed and were not present at some sites. However, as in other populations in NSW (Benson 1993), there were frequent examples of coppicing in the Black Jack Mountain population.

Acknowledgements

We wish to thank Bob Howarth for drawing our attention to the population at Gunnedah and for showing us the location. Penny Gardiner and Terry Curran assisted with field work or logistics and are thanked for their general support. Chris Burgess, Site Manager, Black Jack Colliery, gave us permission to access the stands described in this paper. Ian Telford, Geoff Robertson, James Faris, Sue Cox, Lachlan Copeland, Paul Sheringham, Peter Hind, Travis Peake, Stephen Bell, Bill McDonald, Julian Wall, Joanne Lello, Don Butler, Peter Clarke, John Williams and Jeremy Bruhl are gratefully thanked for information concerning Cadellia pentastylis and/or comments on the draft manuscript. Comments from Doug Benson and anonymous reviewers improved the text. Dave Mitchell kindly prepared the map of Cadellia pentastylis populations.

Finally, we wish to dedicate this paper to the late John B. Williams, Fellow of the University of New England, who recently passed away. John taught Botany to SRC and had many discussions with TJC on ooline and dry rainforest vegetation. His sharp insights, gentle nature and companionship will be sorely missed.

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